On Dairy, Economic Sustainability and Governmental Support in Reunion Island: A Research Note

Marijke D'Haese[a, *], Philippe Lecomte[b], Rob Schipper[a], Véronique Alary[c] and Agniezka Kowalska[a]

[a] **Development Economics Group, Wageningen University, The Netherlands, Hollandseweg 1, 6706KN Wageningen, The Netherlands, Marijke.Dhaese@wur.nl**

[b] **Pôle ELEVAGE, CIRAD REUNION, Saint-Pierre, La Réunion**

[c] **Unité de Recherche Systèmes d'Elevage et Produits Animaux, CIRAD, Montpellier**

Paper prepared for presentation at the 106th seminar of the EAAE

Pro-poor development in low income countries:

Food, agriculture, trade, and environment

25-27 October 2007 – Montpellier, France

On Dairy, Economic Sustainability and Governmental Support in Reunion Island: A Research Note

Abstract

This paper presents the research framework of an on-going study on the dairy sector on La Reunion. This Indian Ocean island is one of the French overseas departments. However, it struggles with similar problems as the developing areas in its neighbourhood, high levels of unemployment especially being a major concern. The agricultural sector therefore justifies the state support it receives by indicating the creation of employment and economic activity. Our focus is on the dairy sector on the Island, which is relatively recent and highly organized. Local milk production has increased over the years, yet farmers are aware of future policy reforms that should liberalize the sector. The outcome for the sector is a major concern. Our research question is to what extent milk production is sustainable on La Reunion, including the question of a future without governmental subsidies. The aim of this paper is to discuss a conceptual framework, relevant research questions and methodology to answer these research questions.

1. Introduction

Why support an agricultural activity, i.e. the dairy sector, in an environmentally disadvantaged area such as Reunion Island? Does it stimulate employment and economic development? Is there potential for growth, even without governmental support? Due to its small size, location in the Indian Ocean and accidental terrain, the potential for agricultural activity on Reunion Island is limited. The island once thrived from sugar cane plantations of which the derived products still are the main agricultural export products. Today, tourism and financial aid from the French government support the economy (BBC, 2007).

Farmers in La Reunion benefit from different support measures from the French government and European Community (EC). With Martinique, French Guiana and Guadeloupe, La Reunion is one of the French overseas departments (Départements d'Outre Mer), and in 1982 the island received a status of French Region (Région d'Outre Mer). According the EC treaty it is an outermost region where the EC objective 1 support applies.

The milk chain at La Reunion is highly organized and streamlined by an inter-professional association[1] and, supported by several development programmes, milk production and the number of cows have increased (Louhichi *et al.*, 2004b). Furthermore, the different actors in the supply chain consider that the dairy sector in La Reunion still has even more potential to fulfil. There is a market demand for local milk products, and the milk quota attributed to the overseas departments is far from being reached. The milk quota for the overseas French departments has been raised to 40 million tons (Louhichi *et al.*, 2004b), yet it

[1] As will be explained later in this paper, the inter-professional association ARIBEV regroups the different actors in the pork, meat and milk chain as well as the importers, processors and distributing sector. It furthermore manages several intervention funds (IEDOM, 2006).

is worth noting that the European Commission is currently developing a phasing out of the milk quota; therefore it might become a less relevant 'target' for Reunion's milk production.

The aim of this paper is to present a research framework for studying the (economic, social and environmental) sustainability of dairy farming on La Reunion. While Louhichi *et al.* (2004a,b), Alary (2006) and Nidumolu (2006) investigate the economic and environmental sustainability of La Reunion's dairy sector at a farm level, we opt for an aggregated economy-wide approach. In this paper we give an overview of the issues at stake and present relevant research questions[2].

2. Background

2.1 Agriculture on La Reunion

The island hosts almost 800 000 inhabitants (785 221 in January 2006), with a population growth of 1.6 percent in 2005 (IEDOM, 2006). In recent years, the average yearly GDP growth has been at 3.9 percent. However, this economic growth has not been sufficient to counter high levels of income inequality and unemployment. It is estimated that 31.9 percent of the active population was unemployed in 2005 (IEDOM, 2006).

The land in agricultural use on La Reunion is mainly arable land (73.7%). The remainder are pastures (21.8%), perennial fruits (4.2%), flowers (0.2%) and vineyards (0.1%). As mentioned above, sugar cane is still the most important crop (72.1% of arable land or 53% of agricultural land) with other crops being vegetables and cereals. In 2003 La Reunion counted 7,622 farms (compared to 14,490 farms in 1988) (INSEE-Reunion, 2006).

Dairy production on La Reunion started in 1960-70s and since then milk production has steadily grown. Being well-organized (cooperative implementation in 1962 and dairy processing since 1972, see next section for details) it has taken advantage of economic and social development programmes. More specifically, it has benefited from a regional highlands development plan (*Plan d'aménagement des Hauts)* with, amongst others, investments for clearing land for agricultural purposes, provision of infrastructure and support for creating pastures. The milk sector was further supported in the 80s by a '*Plan de développement laitier'*. The establishment of a Fund for development of milk production (*Fond de développement laitier*) enabled direct support of milk prices, financing milk collection, quality control and more. During the 1990s the establishment of a new dairy processing firm, changing milk collect procedures, support policies for the unemployed and disease breakouts truly marked the evolution of the dairy sector (Alary *et al.*, 2002; Louhichi *et al.*, 2004b; Alary, 2006).

Over the last years, the number of dairy farms has decreased, but the total number of milking cows and hence local milk production has increased (SICA-Lait, 2007) (Table 1). A detailed account on the diversity among dairy farms types is given in Alary *et al.* (2002).

[2] It is important to note that this paper presents on-going research. In a first instance we focused on the economic part. At the time of the deadline for the EAAE seminar, empirical results were not yet available. However, data have been collected and we expect the empirical model to be ready in the coming months, with results ready for possible presentation at the seminar in October.

<< Insert Table 1 about here>>

2.2 Organisation in the milk chain

In 1962 a cooperative of dairy farmers started as the SICA-Lait, or *Societé cooperative d'intérêt collectif de lait* (IEDOM, 2006; Louhichi *et al.*, 2004b). Its major activities were the collection, bulking and processing of local milk. In 1972 the processing of milk and commercialisation of dairy products was taken over by CILAM (*Compagnie Laitière des Mascareignes*). From then on, SICA-Lait devoted its activities to the collection of milk and the provision of material and technical support to milk farmers (Louhichi *et al.*, 2004b) (Figure 1).

<< Insert Figure 1 about here >>

Almost all milk produced on the island is collected by SICA-Lait. It is tested on fat and protein content, bacterial and somatic cell count and farmers regularly receive accounts of the quality of milk they supply. If the bacterial quality of the milk is satisfactory for three months in a row, the farmers receive a premium, which should be an incentive for the farmers to invest in milk quality.

The milk collected and bulked by SICA-Lait is sold to CILAM for processing, into UHT bricks, yoghurt, ice cream and cheese. Local milk may be mixed with imported milk powder in the final product, yet for such dairy products, CILAM is compelled to mention on the package that the product contains imported milk powder. To target consumers with a preference for locally produced milk, CILAM has developed a particular brand 'Piton des Neiges'. Furthermore, CILAM has acquired the brand name 'Yoplait' for La Reunion. Sorelait is the second dairy processor on the island, importing milk powder to process mainly into yoghurt (marketed as 'Danone'). It can be estimated that 75 percent of the milk and cheese products consumed on La Reunion are imported, the total milk consumption (in milk equivalent, calculated as the sum of total imported (customs statistics) and locally produced milk and milk products) on the island averaging 137l/person in 2005, far below the metropole level of 330 l/person (Cniel, 2005)

Large supermarket chains, such as Carrefour, Casino and Géant, have recently invested in different retail outlets on the Island. They buy dairy products such as UHT milk, yoghurt, ice cream and cheese from CILAM and Sorelait, which are put on the shelves alongside imported products. Butter, for example, is not produced on La Reunion.

Feed for cows, such as concentrates, are mainly supplied by URCOOOPA/Sanders. Urcoopa is the union of agricultural cooperatives on Reunion Island and specializes in animal nutrition and feed concentrate supply. Additional cane straw and hay are supplied by sugar cane farmers to overcome seasonal forage deficits.

Culled cows and male calves are sold to SICA-Revia. Female calves are kept on the farm to be raised into heifers or sold to SICA-Lait. The latter has its farm on which heifers are

raised, inseminated and sold back to the farmers. SICA-Lait has invested in an own farm for at least two reasons. On the one hand it wanted to prevent female calves being sold for slaughter, which might lead to a shortage of heifers and create a parallel market. The annual raising a herd of heifers enables SICA-Lait to provide farmers with cows if they want to enlarge their farm or for new farmers to start a dairy farm. On the other hand, controlling the insemination of heifers guarantees genetic diversity on the island.

ARIBEV (*Association réunionnaise interprofessionnelle pour le bétail et les viandes*) is an inter-professional organisation that regroups all actors within the milk chain. ARIBEV was created in 1975 for the beef, milk and pork chain, and an inter-professional association for the poultry sector started in 1994. These inter-professional associations also include representatives of the distributors and importers who are highly involved in the development of local production. It provides a discussion forum, enables the enforcement of agreements throughout the chain and defends the interests of its members. All associations within ARIBEV represent at least 60% of the local market, giving ARIBEV the possibility to request the Minister of Budget to enforce agreements made within ARIBEV for the whole Island.

ARIBEV furthermore hosts the FODELAIT (*Fonds de Développement de l'Elevage Laitier*). FODELAIT was established in 1980s as part of the Poseidom programme. Its main activities are to support milk prices and provide milk quality control and financial support for milk collection. Poseidom is a special programme created in order to overcome disadvantages because of the ultra-peripheral location and isolation of the overseas departments. Apart for the Poseidom programme, in which the fixed price of milk to farmers is the main characteristic, dairy farmers are supported for several activities and investments. See Louhichi *et al.* (2004b) for a detailed overview.

3. Research activities

3.1 Conceptual framework

Figure 2 shows a conceptual framework of the study. The direction of the arrows indicates the causal relationships we put forward.

<< Insert figure 2 about here >>

Central in our framework is the increase of local milk production. We assume that this can be reached by either one of the following developments, namely: (a) start of new farms; (b) increased productivity on existing farms; and (c) increased herd sizes on existing farms. Increased local milk production will contribute to economic development by creating employment and local agricultural activity if the benefits outweigh the costs. The impact will even be larger if significant production linkage effects arise within the upstream and downstream sectors.

The increased milk production should be supported by conducive land tenure arrangements and an effective and efficient supply chain driven by an increased demand for local milk. Furthermore, solutions need to be adapted for more effective waste management.

Finally, there is the role of governmental and European support programmes. These are important towards developments at farm level. However, it is arguable that part of the subsidies will be earned back in taxes.

3.2 Research questions

Given the assumptions on the economy-wide impact of the development of the dairy sector on Reunion Island, our main interest is to study the issues that affect economic, social and environmental sustainability in the framework presented above. The concomitant research question is therefore: 'How sustainable is local milk production on La Reunion?' Three sub-questions arise, namely:

(a) Is milk production economically sustainable? We thereby distinguish the economic importance of a growing dairy sector in agricultural development and employment creation; and the economic sustainability if no direct financial support is provided by the government or EC.
(b) Is the dairy supply chain on La Reunion socially sustainable? This question refers to the social cohesion that is important in the supply chain as well as the consumer preference given to local products; and
(c) Is increase in milk production environmentally sustainable? A major issue in this respect is the problem of land scarcity and animal waste management through better integration with sugar cane and vegetable sectors.

In figure 3 the research questions are placed in the conceptual framework, resulting in three 'poles' of investigation. The hypotheses put forward are given in the next section.

<< Insert Figure 3 about here >>

3.3 Hypotheses

3.3.1 Increased demand for local milk

As mentioned above, an increase in demand for locally produced milk is the main driver in the conceptual framework. According to personal interviews with representatives of the milk cooperatives, an increased demand for local milk is relevant for La Reunion. In particular the milk processors Cilam indicated that they would use more local milk if available. Increased transport costs (milk powder and dairy products) and higher world market prices for milk powder explain much of the interest of the processors.

Unlike in other European regions, dairy farmers on La Reunion have not yet reached their milk quota. They can increase production up to 40 million litres. Furthermore, the EU support enables SICA-Lait to pay farmers a fixed price per litre. It is therefore likely that increased production will not influence local milk prices.

At the time of research, Cilam marketed one brand of UHT milk made from local milk. The current milk consumption on the island is far below the averages for continental

France (see above). Arguably, there is also reason to believe that final consumption will increase, not only for liquid milk, but also for yoghurts, ice creams and cheese.

Hypothesis 1: Economic sustainability of dairy production and agricultural sector in general, and the contribution of agricultural activities to economic development depends on the increased demand of local milk matched by increased local production capacity.

3.3.2 Local identity

In a second instance, we assume the social sustainability of the dairy chain. We distinguish the (a) creation of a local identity by consumers (not only are they assumed to demand more dairy products, but also to search for and buy local dairy products) (see above); and (b) keeping in place the cooperative-interprofessional organization of the dairy chain. The latter depends on issues such as trust and 'entente', or in other words social capital among the actors in the diary chain.

Hypothesis 2: An effective and efficient dairy supply chain is built on a well-organised organization among actors in the chain and driven by increased interest in locally produced dairy products.

3.3.3 Environmental sustainability

The potential for local milk production will highly depend on the availability of land. Land is needed to feed the cows and for manure spreading. As mentioned above, little land is available. Therefore other measures need to be developed and implemented.

Hypothesis 3: If the local milk production is increased, solutions for effective waste management and for keeping cows on less land will need to be found.

3.4 Methodology

We start by assessing economic sustainability, with this section explaining the methodology approach and giving an overview of the data sources used.

3.4.1 Economic sustainability

To assess the impact of an increase of milk production on economic development, we have built a Social Accounting Matrix (SAM) for the economy of La Reunion. The SAM is disaggregated for the dairy sector and is used to measure the effect of other changes in the chain such as a decrease in milk price or an increase in input costs. To check the feasibility and limits at farm level of the changes proposed, we estimate a frontier of most efficient farms and its determinants, using a Data Envelopment Analysis (DEA) approach.

a. Social Accounting Matrix

In the first instance we are building a Social Accounting Matrix (SAM) for la Reunion with disaggregation of the dairy sector using detailed data on milk production, collection and processing (Figure 4). A SAM is a simple and efficient way of representing the resource flows within an economy (Pyatt, 1988).

<< Insert Figure 4 about here >>

SAMs were first developed in the 1950s as an extension of the national accounts, with the aim of integrating economic and social aspects of development (Pyatt and Round, 1979). SAMs have been frequently used to analyse the potential effects of a change in a national, regional or village economy[3] (some examples are Lewis and Thorbecke (1992), Parikh and Thorbecke (1996), Taylor and Adelman (1996), Thorbecke and Hong-Sang (1996), Rich *et al.* (1997), Khan (1999) and Psaltopoulos *et al.* (2004) to name some). However, disaggregating the agricultural sector with a focus on one particular chain is less common (a SAM has been built for the sugar cane industry (Fusillier *et al.*, 2003) and for the poultry industry (Parrot *et al.*, 2004) on La Reunion).

In general, a SAM is a square table in which the rows and the columns represent the receipt and expenditure accounts of various economic sectors respectively. All rows and column sums must be equal (Lange *et al.*, 2002). The conventions of double-entry bookkeeping guarantee that there will be no leakages into the system and that there is no room for any 'statistical discrepancy'. Every flow must go from one actor to another within the matrix (Adelman and Robinson, 1986).

A SAM can be used for simple modelling exercises. The effects of exogenous injections or shocks on a whole economic system, for example, can be explored by multipliers derived from the SAM. Exogenous accounts within the matrix are those for which it is assumed that expenditure is set independently from income, and the choice of exogenous accounts dictates the range of shocks that can be studied (Sadoulet and de Janvry, 1995).

The development of the SAM for an Island has several analytical advantages. The local economy can be fairly well represented as products are either produced locally or imported by sea or air; the delimitation of the research area is simply determined by its coasts; and the number of activities is limited, which improves the overall quality of the data.

b. Data Envelopment approach for identifying scenarios

Efficiency levels are calculated using a Data Envelopment Approach (DEA). The DEA has the advantage of being a non-parametric method in order to measure the production frontier. No explicit mathematical form of the production function needs to be assumed; it accounts for

[3] At this stage, we are not (yet) considering exploring Computable General Equilibrium models (CGE), which could be an extension to the SAM.

multiple inputs and outputs and the farms can be directly linked to a more efficient peer or combination of peers. The DEA can be computed from an output-maximizing and/or input-minimizing point of view, taking into account constant or variable returns to scale.

Louhichi *et al.* (2004) has modelled the growth potential of farms, accounting for their specific characteristics. Our interest, however, is identifying the farms on the production frontier. The DEA should provide a general indication of the highest efficiency reachable on farms in La Reunion, assuming that all farms operate with similar production technology.

A first approach of DEA for dairy farms on La Reunion is discussed in Hoareau (2002) and Blancard *et al.* (2006). Their study concludes that efficiency may be raised for three quarters of the farms, allowing the farmers to reduce costs or increase production. Costs can be saved by reaching an optimal herd size, reducing the costs for concentrates, other feeds and operational costs.

Our goal for the DEA is to build on the analyses done by Hoareau (2002). We focus on the levels to which total production can be increased. This should provide an idea of the limits of changes possible for each scenario for future development. Possible scenarios are (a) an increase in production by increasing the herd size; (b) an increase in total production by improving the productivity per cow (e.g. changing input levels); and (c) the creation of new farms.

A second round of scenarios accounts for changes that would affect production negatively, such as: (a) an increase in the price of inputs; and (b) the end of direct support of milk prices. The issue of input costs is particularly relevant for La Reunion, since it heavily depends on imported products and materials. Increases of prices in international markets or transport costs are also expected to have a significant impact. Furthermore, the second issue on reforms within the European agricultural policy that might lead to changes in the direct price support of dairy farmers (see also Louhichi *et al.* (2004b) and Bony *et al.* (2005)[4]), is probably an even greater concern to the dairy chain. Farmers feel increasingly vulnerable towards the liberalization of the market. This could have a severe impact on their livelihoods.

3.4.2 Social sustainability

A second part of our research agenda is to study social sustainability. As explained above, the milk supply chain is strongly built on well-organised institutions. In this respect, we identify several research issues. Firstly, we need to have a good understanding of the structural and institutional aspects of the chain organisation and secondly, we should investigate the social cohesion that keeps the chain together. It would be interesting to study the importance of social capital (trust and associability) on the organisation of the chain and its impact on transactions costs (contract agreements, monitoring, enforcement, etc.).

A third aspect determining the social sustainability of milk production on La Reunion is the importance consumers attach to 'local' products. This research builds on a premise that there is an increase in demand for local products, and a consumer study is likely to shed light

[4] As explained above, the milk price is currently fixed. The paper by Bony et al. (2005) discusses the variability in milk quality in La Reunion, which would become important if milk price was dependent on its quality.

on the determinants of choice of consumers. Consumer surveys and focus groups could provide insights on the growth potential of local dairy products, questions arising being the willingness to pay for locally produced dairy products, for example.

3.4.3 Environmental sustainability

A final yet critical issue is environmental sustainability. The problem of waste management is especially critical at La Reunion, given the limited land available. Aubry *et al.* (2006) mention difficulties such as the European and French regulations, mountain slopes, population density and proximity of rivers and streams reducing the land available for applying manure. As a result, farmers sometimes spread waste illegally or apply excessive quantities (Aubry *et al.*, 2006). This is rapidly changing, however, with the application of rules and spreading areas, while farmer are contracting with the sugar cane or horticultural sector.

On-going research reported in Nidumolu (2007), in a bio-economic modelling exercise, investigates the nitrogen use in dairy farms and explores nitrogen management options. Our research could in fact aggregate the results and estimate the environmental impact of the scenarios mentioned.

Future research could address the energy use at farm level compared to the energy cost of the import of milk powder for local milk transformation.

3.5 Data sources

At the time of the seminar's deadline, data had been collected and analysed to fill in the SAM, with the year 2005 chosen as the matrix reference. For this purpose, interviews with key-informers were undertaken and details from accountants enabled to assess revenues and costs of the actors in the dairy chain, as well as details on feed and meat production, input and output for dairy sector, were also collected.

The Department of Agriculture (DAF) provided aggregate data on other agricultural sectors and data on other sectors of the economy at La Reunion were received from INSEE (National statistical institute).

A detailed survey of farmers conducted by CIRAD in 2000 will be used for farm accounting and the DEA. Structural, social and economic data has been collected for 32 dairy farmers (Alary *et al.*, 2002) and used to study the factors determining the efficiency levels of the dairy farms.

4. Discussion

La Reunion presents a unique possibility to research the importance and impact of a growing agricultural sector for economic development; and to study the possible effects of liberalization policies. In the research framework presented, we account for at least three of the five topics of this EAAE seminar, namely (1) agricultural trade and economic

development; (2) natural resources; and (3) supply chains. The research hypothesis is that growth of the dairy sector, given its economic, social, and environmental settings and constraints, may create employment and production linkages, eventually contributing towards real economic development.

Farmers in La Reunion are beneficiaries of more support programmes than any neighbouring developing country, such as Madagascar and if anything, this research provides a unique opportunity to investigate sustainability issues of external support measures in the promotion of the agricultural sector. The link with development programmes is clear. Similar questions are posed, such as (a) what is the value of money invested, (b) will the programme create social imbalances, and (c) does the intervention not create environmental burdens? Arguably, these are the same questions posed in research on pro-poor (non-) agricultural development. Furthermore, the advantages of research on La Reunion are the limited size of the island, its relatively small number of farmers and a well-organized supply chain.

References

Alary, V., Messad, S., Taché, C. & Tillard, E. (2002). Approche de la diversité des systèmes d'élevage laitiers à la Réunion. Revue d'élevage et de medicine vétérinaire des pays tropicaux, 55(4): 285-297.

Alary, V. (2006). Modélisation des systèmes d'exploitation laitière à La Réunion, juin 2000-sept. 2004, Rapport de synthèse, Opération ELE 105: "Modélisation technico-économique des exploitations laitières à La Réunion ". Pôle Elevage La Réunion, CIRAD-Emvt, SICA Lait, 125 p. + annexes.

Adelman, I. & Robinson, S. (1986). US Agriculture in a General Equilibrium Framework: Analyis with a Social Accounting Matrix. American Journal of Agricultural Economics, 68(5), Proceedings Issue: 1196-1207.

Aubry, C., Paillat, J.-M. & Guerrin, F. (2006). A conceptual representation of animal waste management at the farm scale: The case of the Reunion Island. Agricultural Systems, 88: 294-315.

Blancard, S., Hoareau, L. & Choisis, J.P. (2006) An evaluation of dairy farms efficiency in La Reunion using Data Envelopment Analysis. In U. B. Nidumolu, V. Alary, Ph. Lecomte (Eds), 2006. "Modelling Environmental Risk in the context of Environmental, Social and Economic Sustainability: With reference to Dairy Sector in La Réunion". CIRAD EMVT, Proceedings of the International Training Workshop. Saint Pierre, La Reunion (France), June 12-16, 2006. 16p.

Bony, J., Contamin, V., Gousseff, M., Metais, J., Tillard, E., Juanes, X., Decruyenaere, V. & Coulon, J.-B. (2005). Facteurs de variation de la composition du lait à la Réunion. INRA Productions Animales, 18(4): 255-263.

CNIEL (2005). Confédération Paysanne. www.confederationpaysanne.fr.

Fusillier, J.L., Basquin, H. & Benoit-Cattin, M. (2003) Les effets d'entraînement de la filière de production de sucre sur l'économie réunionnaise évalués par une matrice de comptabilité sociale. In : Les organisations sociales dans la gestion des territoires, des

ressources, des filières, des services. Journées des sciences humaines et sociales, 8-10 septembre 2003, Montpellier, France / CIRAD-MES. -13 p.

Hoareau, L. (2002). Diagnostic de l'efficacité productive des élevages bovins laitiers de La Réunion par la Méthode DEA. 70 p + annexes. DESS MQME, Université de La Réunion.

IEDOM (2006). La Réunion en 2005. Institut d'Emission des Départements d'Outre-Mer. Paris.

INSEE-REUNION (2006). TER 2006-2007. www.insee.fr.

Khan, H.A. (1999). Sector growth and poverty alleviation: a multiplier decomposition technique applied to South Africa. World Development, 27(3): 521-530.

Lange, G.M., Schade, K., Ashipala, J. & Haimbodi, N. (2002). A Social Accounting Matrix. Working Paper no 97. The Namibian Economic Policy Research Unit.

Lewis, B.D. & Thorbecke, E. (1992). District-level economic linkages in Kenya: Evidence based on a small regional social accounting matrix. World Development, 20(6): 881-897.

Louhichi, K., Alary, V. & Grimaud, P. (2004a). A dynamic model to analyse the bio-technical and socio-economic interactions in dairy farming systems on the Réunion Island. Animal Research, 53: 363-382.

Louhichi, K., Alary, V., Choisis, J.P., Tillard, E. & Grimaud, P. (2004b). Application d'un modèle économique dynamique à l'analyse prospective des systèmes d'élevage laitiers à la Réunion. Rapport . Cirad-Elevage, St Pierre, La Réunion, Octobre 2004.

Nidumolu, U. (2007). Regional bio-economic modelling of dairy sector in a unique island setting: A case of Isle de La Réunion. Report, CIRAD, St Pierre, Réunion.

Parikh, A. & Thorbecke, E. (1996). Impact of rural industrialization on village life and economy: a social accounting matrix approach. Economic development and cultural change, 44: 351-377.

Parrot, L., Fusillier, J.-L. & Basquin, H. (2004). Impact économique des filières de production animales à la Réunion – Effects d'entraînement de la filière volaille. Report CIRAD - TERA, Reunion Island.

Psaltopoulos, D., Thomson, K.J., Efstratoglou, S., Kola, J. & Daouli, A. (2004). Regional social accounting matrices for structural policy analysis in lagging EU rural regions. European Review of Agricultural Economics, 31(2): 149-178.

Pyatt, G. (1988). A SAM Approach to Modelling. Journal of Policy Modelling, 10(3): 327-352.

Pyatt, G. & Round, J.I. (1979). Accounting and Fixed Price Multipliers in a Social Accounting Matrix Framework. The Economic Journal, 89: 850-873.

Rich, K.M., Winter-Nelson, A. & Nelson, G.C. (1997). Political feasibility of structural adjustment in Africa: an application of SAM mixed multipliers. World Development, 25(12): 2105-2114.

Sadoulet, E. & de Janvry, A. (1995). Quantitative development policy analysis. Baltimore: Johns Hopkins University Press.

Taylor, J.E. & Adelman, I. (1996). Village Economics: The Design, Estimation and Use of Village wide Economic Model, Cambridge: Cambridge University Press.

Thorbecke, E. & Hong-Sang, J. (1996). A multiplier decomposition method to analyse poverty alleviation. Journal of Development Economics, 48(2): 279-300.

Tables and figures

Table 1. Milk production on La Reunion (SICA-Lait, 2007)

	2000	2002	2004	2006
Milking farms (nb)	151	146	135	123
Milk production (‘000 l)	20,257	22,090	23,847	24,614
Milking cows (nb)	3,849	4,202	4,192	4,090
Milk production per farm (l)	134,153	151,305	176,645	200,110
Average yield per cow/year (l/cow)	5,140	5,710	5,600	5,950

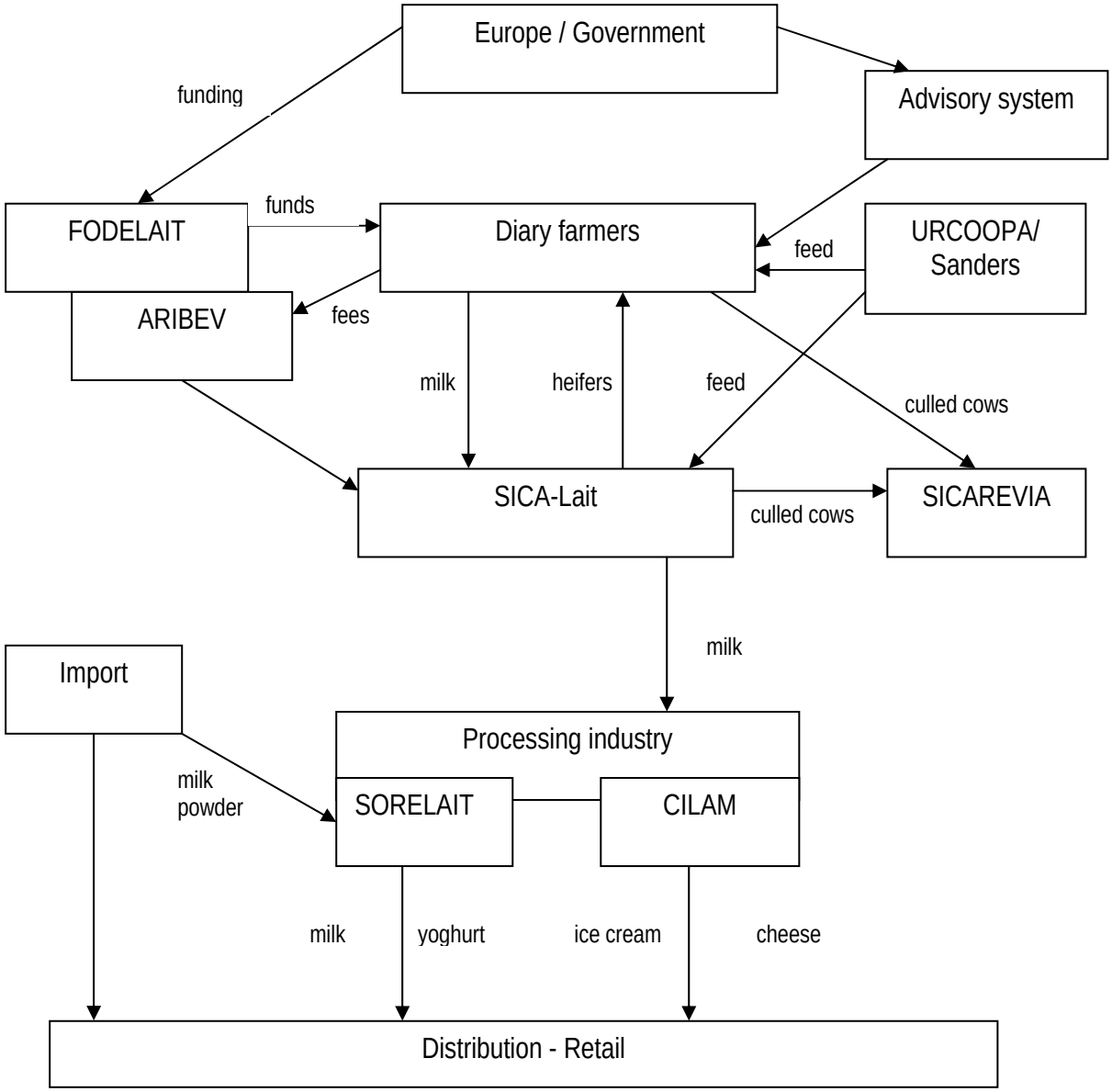

Figure 1. Milk supply chain in La Reunion

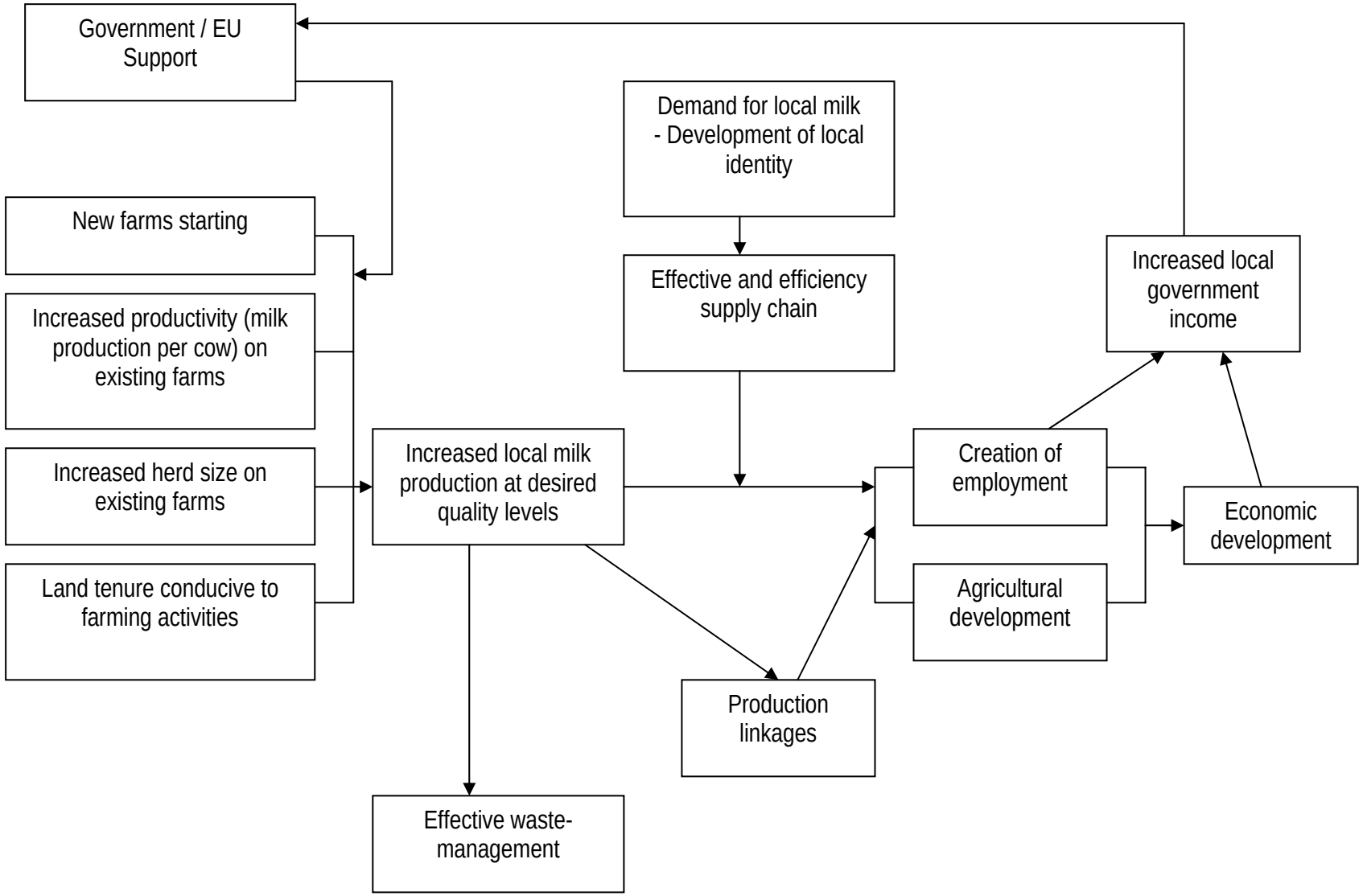

Figure 2. Conceptual framework

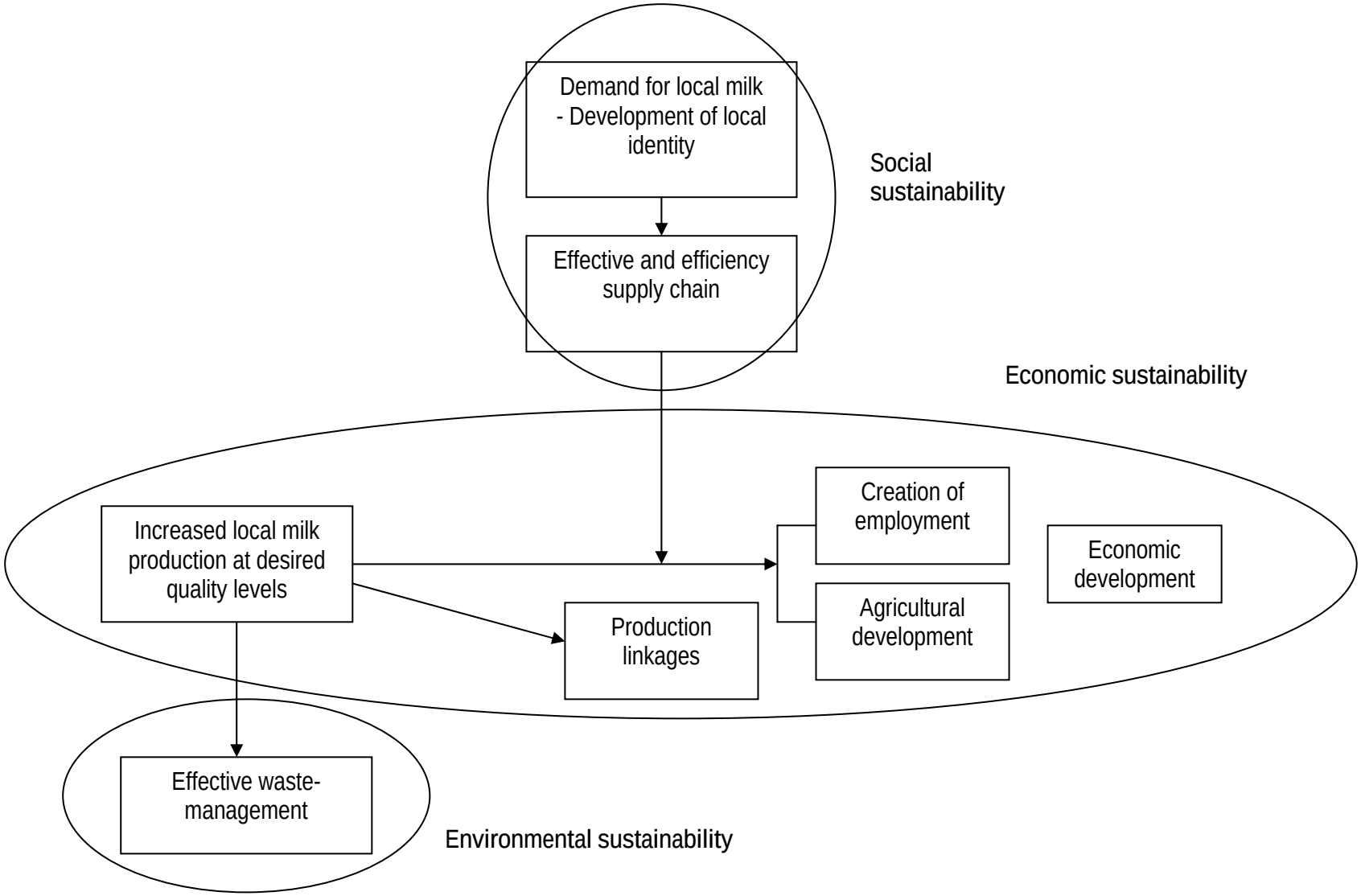

Figure 3. Research poles

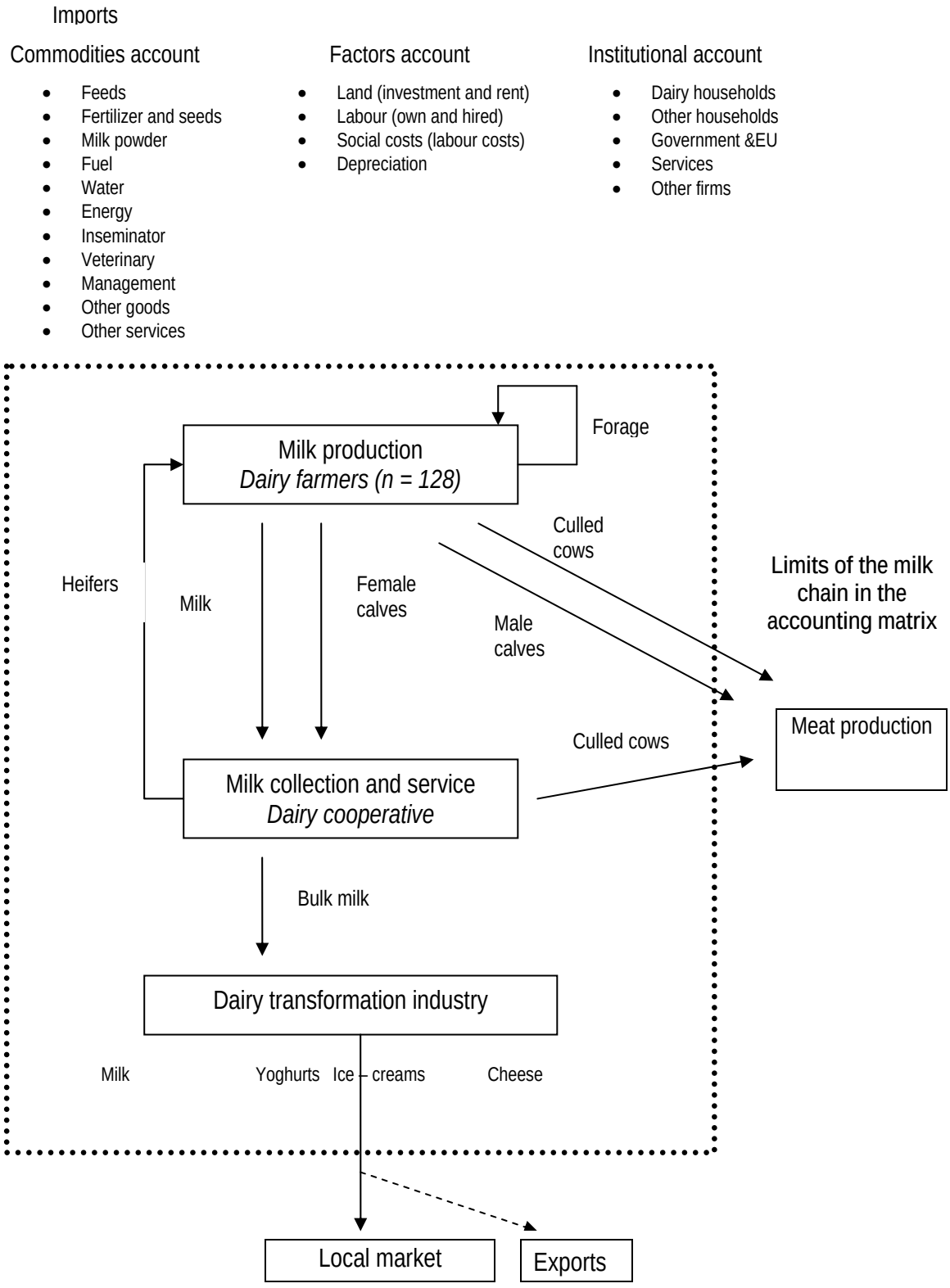

Figure 4. Milk chain in the Social Accounting Matrix